EXPRESS MAIL NO. EV719383955US

SUBSTITUTE SPECIFICATION
ATTORNEY DOCKET NO. 481062.410

DUAL CONTRAST EMBEDDED MESH FOR IDENTIFICATION OF VARIOUS COMPOSITE MATERIALS

Field of the Invention

This invention relates to embedded labels and bar codes. Specifically, this invention relates to embedded labels and bar codes for composite materials that can be used with both dark-colored and light-colored composites.

Description of the Related Art

Direct marking of composite materials or parts such as Kevlar, fiberglass, carbon fiber, etc. with a data carrier is difficult for several reasons. First, the data carrier, which carries a marker or indicia, must be very thin and porous to avoid affecting the functionality of the part to be marked. Second, the data carrier must be relatively simple to use. Third, in many applications the marker and/or indicia must be visible against the composite material so that the coding or indicia can be read. Separate labels are used to mark dark- and light-colored composites. It is desirable to have a data carrier that can be used with both light and dark-colored composite materials. This invention eliminates the problems that existing data carriers have with these issues.

One prior art method of marking composite materials is to embed printed fabric into light-colored composite materials as a way of marking them for identification purposes. This process involves the encapsulation of a white typewriter-printed fabric within a heat-curable resin on the surface of the composite material being marked. It does not provide a means of marking dark-colored composite materials. A data carrier with dark-colored ink does not provide sufficient contrast on dark surfaces. Similarly, prior art ribbons with excellent contrast on dark surfaces, using lighter colored pigments or reverse printing on a light-colored mesh, do not provide enough contrast when adhered to lighter colored surfaces.

A composite part is coated with thermally curable liquid resin that will be baked at a high temperature to reinforce and protect the composite part. Before the resin is cured, a data carrier is placed onto the liquid resin, adhering the data carrier to the composite material or part. A second coating of liquid resin is applied over the data carrier. The resin is then cured. There is a need for a means of marking composite materials for identification that will not affect the functionality of the composite material. Accordingly, it is another object of the present invention to provide a means for marking composite material that does not affect the functionality of the part and which is simple to use.

There is a need for a single product that can be embedded into a composite part made of either light-colored or dark-colored composite and still provide enough contrast to decode the bar code.

SUMMARY OF THE INVENTION

A composite component is created by laminating flexible layers of Kevlar, fiberglass, carbon-fiber, etc. with a liquid resin. When the resin cures, the composite component becomes a hardened stable component. A printed mesh is pressed into the resin before curing or may be applied to a part of the composite component in a separate later step. Once the resin hardens, the printed mesh becomes a permanent part of the composite component. When the printed mesh is permeated with the liquid resin, the printed mesh becomes translucent. Identifying marks on the printed mesh are visible on the surface of the finished composite component.

An object of this invention is a single mesh carrier that can be embedded into a composite component, which can be made of either light-colored (for example, yellow Kevlar) or dark-colored (for example, carbon composite) composite materials, and that the mesh carrier will still provide enough contrast to view or read a bar code or other indicia on the carrier mesh for both light-colored or dark-colored composite materials.

A two-layered print ribbon--one ink layer being light-colored and the other ink layer being dark-colored--is used to print a two-layer symbol, bar code, image or indicia on a mesh carrier. The mesh carrier becomes translucent when permeated by liquid resin. The imaged mesh carrier becomes an integral element of a finished composite component.

BRIEF DESCRIPTION OF THE DRAWING(S)

Figure 1A is a schematic representation of an expanded cross section of a light composite material with an embedded mesh carrier carrying a bar code printed with two-layer ink.

Figure 1B is a schematic representation of an expanded cross section of a dark composite material with an embedded mesh carrier carrying a bar code printed with a two-layer ink.

Figure 2 is a schematic representation of a cross section of a mesh carrier carrying a bar code printed with a two-layer ink.

Figure 3 is a schematic representation of a printer ribbon.

Figure 4 is a schematic representation of a dark-colored composite with a mesh carrier carrying a bar code printed with a two-layer ink.

Figure 5 is a schematic representation of a light-colored composite with a mesh carrier carrying a bar code printed with a two-layer ink.

Figure 6 is a printed bar code on the mesh carrier.

Figure 7 is a bar code on a light-colored composite.

Figure 8 is a bar code on a dark-colored composite.

DETAILED DESCRIPTION OF THE INVENTION

Composite materials 10 are typically formed from at least one reinforcing material and a matrix. The reinforcing material may be, for example, fiber, particulate, or a laminate. Matrix materials may be, for example, ceramic or polymers. Through the selection of variables such as reinforcing material(s),

matrix material, composition and reinforcement arrangement composites with a wide range of properties have been developed. Common composite materials are glass-polymer, graphite-polymer, Kevlar-epoxy, Kevlar-polyester and carbon-carbon composites. Polymer and ceramic matrix composites are widely used, for example, in automotive, marine, aircraft, and aerospace components. They are also used in sporting goods, such as tennis rackets, skis, and fishing rods.

An imaged mesh or printed mesh that is adhered to a composite component becomes an integral element of the finished composite component. Composite components are created by laminating flexible layers of Kevlar, fiberglass, carbon-fiber, etc. with a liquid resin. When the resin cures, the layers become a hardened stable composite component. An identifying mesh or data carrier or mesh carrier or printed mesh is pressed into the resin before curing. Once the resin hardens, the mesh becomes a permanent part of the component. Alternatively, the mesh carrier can be attached to the composite component at a later step. Any identifying marks on the mesh carrier are then visible as a mark in the surface of the finished composite component. Preferably, when the mesh carrier is permeated with the liquid resin, the mesh carrier becomes translucent.

A label or medium 13 for marking a substrate of a composite material is comprised of a mesh carrier 12 having indicia 14 printed thereon. The indicia 14 includes a layer of dark-colored ink 102 and a layer of light-colored ink 104.

For applications with visible markers, the medium 13 must provide sufficient contrast with the base item such that the visible markers can be read. The printed indicia must provide sufficient contrast with the base item. This has been a challenge if use of a single medium is desired for embedding in both light and dark surfaces.

When marking a light-colored substrate 112 with the medium 13, position the mesh carrier 12 such that the dark ink layer 102 of the indicia 14 faces towards a scanner.

When marking dark-colored substrates 114, flip the mesh carrier 12 over so that the light-colored ink 104 of the indicia 14 is facing a scanner. The white or light-colored layer of ink 104 will be visible through the mesh carrier 12 or a porous mesh carrier in the finished composite product and the white or light-colored layer of ink 104 will provide adequate contrast with the dark substrate 114 to which it is attached. Thus, the mesh carrier 12 having the indicia 14 print thereon, which includes the layer of dark-colored ink 102 and the layer of light-colored ink 104, eliminates the need for having two separate printing systems within a manufacturing area and ensures that a proper image is marked onto the substrates 10.

The printed mesh carrier can be placed onto the part being marked with either the light-colored ink layer (for dark surfaces) or dark-colored ink layer (for light-colored surfaces) facing a user. The mesh carrier becomes translucent when permeated with the resin. Thus, by simply flipping the printed mesh over, the same medium 13 can be used for both light-colored and dark-colored surfaces. This ensures that a scanner, regardless of what color the substrate is, can read every part marked with the medium 13. Furthermore, there is no need for separate ribbons within the manufacturing environment for light-colored substrates and for dark-colored substrates.

In a first preferred embodiment a porous mesh carrier 12 is printed with a thermal ink. The mesh carrier 12 is then adhered to a substrate for direct parts marking. The porous mesh carrier 12 preferably has a thread-count between 180 and 560 threads per inch. Preferably, the mesh carrier is polyester. Alternatively, the mesh carrier could be made of nylon or other known material, capable of being constructed into a porous mesh or other porous material such as paper.

A single thermal transfer ribbon 110 is used to print an image such as indicia 14. The image provides enough contrast for a scanner when the image is adhered to both dark-colored surfaces and light-colored surfaces. This is done

by using the ribbon 110, which is coated with two separate layers of ink, one on top of the other with one layer of ink being the light-colored ink 102 and the other layer being the dark-colored ink 104.

The printer ribbon 110 comprises the light-colored ink/primer layer 102, a dark-colored ink layer 104, a release primer layer (if needed) 106, and a PET ribbon carrier 108. The layer of dark-colored ink 102 is closest to the printhead. Thus, after the mesh carrier 12 is printed with an image using the ribbon 110, the printed mesh carrier has a layered structure. First, there is a dark-colored ink layer 102, next a light-colored ink layer 104, and then the porous mesh 12.

When adhering the medium 13 onto a light-colored substrate 112, *e.g.* yellow Kevlar, fiberglass, etc., the orientation of the medium 13 would be dark-colored ink layer 102, light-colored ink layer 104, porous mesh carrier 12, and light-colored substrate 112. This orientation of the medium 13 in relationship with the substrate provides excellent contrast. The dark-colored ink 102 is viewed against the light-colored substrate 112.

For a dark-colored substrate 114, *e.g.* carbon fiber, etc., the carrier mesh 12 is the top layer, the light-colored ink 104 is next, then the dark-colored ink layer 102 is closest to the dark-colored substrate 114. The printed mesh carrier 12 is relatively transparent when permeated with resin 16, allowing the image printed with the light-colored ink 104 to show through the mesh carrier 120. The light-colored ink layer 104 has sufficient opacity as to obscure the presence of the dark-colored ink layer 102 and the substrate 114. The white or light-colored layer of ink 104 is visible through the porous mesh 12 in the finished composite component and the white or light-colored layer of ink 104 provides adequate contrast with the dark substrate 114 to which it is attached.

A second preferred embodiment uses a reflective ink layer such as a metallic ink is used for the dark-colored ink layer 102. The metallic ink layer has been shown to provide excellent contrast against dark-colored substrates.

Magnetic ink character recognition (MICR), uses a reader that can discern characters printed onto non-magnetic materials using magnetic ink in much the same manner as optical character recognition (OCR) scanners use contrast between the black image and the white paper to discern the characters. MICR is used to print the account numbers on the bottom of checks to make them easily scanned. Similar magnetic imaging technology will allow persons to scan machine-readable bar codes.

A third preferred embodiment uses a phosphorescent clear ink that would be visible when viewed under a black light. The scanner can be modified so that it scans at the same wavelength as the black light. In doing so, the security of the symbol could be maintained and the use of counterfeit items could be prevented.

The fourth preferred embodiment would involve pre-printing the porous medium using other printing technologies such as screen printing and hot stamp to create the mark. This is useful when one wants to embed static information onto the surfaces to be marked.

A fifth preferred embodiment uses ink jet technology to print dynamic information onto the porous medium using two passes. The first pass prints the light-colored ink 104 followed by a second printing of dark-colored ink 102.

The mesh carrier works for embedding because it is thin and porous, allowing surrounding composite material to flow into the pores and bond with the mesh.

Referring to Figures 1A and 1B, composite material with an embedded mesh carrier having a bar code printed thereon is shown. The composite material consists of a plurality of layers of a composite material 10. Indicia 14 is printed on one surface of the mesh carrier 12. More preferably, the mesh carrier 12 is a porous woven mesh. Most preferably, the mesh carrier 12 is a porous woven mesh that is very thin and porous. The porous woven mesh allows the matrix material of the composite material 10 to flow into the fabric, eg.,

the porous woven mesh, thus bonding the wet mesh with the composite material 10.

The mesh carrier 12 is printed with an appropriate indicia 14. The indicia 14 may be any suitable text, a symbol, bar code or other indication. In the preferred embodiment of the present invention, the indicia 14 is a bar code.

The printed mesh carrier 12 will be embedded in or on the surface 11 of the composite 10 using a heat-curable resin material 16. The composite material 10 can be particulate, laminar, chopped fiber, unidirectional or other known composite type. The resin material 16 is preferably selected based on the composite material. The preferred resin material is a heat-curable resin. Preferably, the mesh carrier 12 with printed indicia 14 is placed on the composite 10 during the manufacturing process and the mesh carrier is coated with the heat curable resin 16. Alternatively, the mesh carrier 12 is placed on the composite 10 after the composite has been manufactured. The resin 16' is then coated over the mesh carrier 12. The printed mesh carrier 12 may be embedded or adhered on the surface 11 of the composite material 10 during manufacture of the composite material or at a later time such as during assembly of a product using the composite material.

The medium 13 comprises the porous mesh carrier 12 printed with the indicia 114 using the two-layer thermal transfer printer ribbon 110. The ribbon 110 as shown in Figure 3 is a light-colored ink layer 104 or primer layer, a dark-colored ink layer 102, a release primer layer 106, if necessary, and a PET carrier ribbon 108. The ribbon 110 is placed in a printer with the dark-colored ink layer 104 closest to the print head and the light-colored ink layer closest to the mesh carrier 12. The printed mesh carrier 12 shown in Figure 2 has the light-colored ink 104 next to the mesh carrier 12 and dark-colored ink 102 on top of the light-colored ink 104. Alternatively, using a different printer ribbon, the dark ink layer could be next to the mesh carrier and the light ink layer on top of the dark layer. The

medium 13 having the layered indicia 14 printed on the mesh carrier 12 can be used to mark both light and dark-colored composites 112, 114.

Referring to Figures 1A, 5 and 7, on a light-colored composite 112, the printed mesh carrier 12 is placed mesh side down on the composite 112. The dark-colored ink 102 is visible. Referring to Figures 1B, 4 and 8, on a dark-colored composite 114, the printed mesh carrier is placed dark-colored ink 102 side down. When the mesh carrier 12 is coated with the resin material 16, the mesh carrier 12 becomes relatively transparent. This allows the image printed with light-colored ink 104 to show through the mesh carrier 12. The light-colored ink layer 104 has sufficient opacity so as to obscure the presence of the dark-colored ink layer 102 and the substrate. The indicia 14 can be read with a bar code reader or scanner.

In an alternative embodiment, the dark-colored ink layer 102 is a metallic ink. Metallic ink has been shown to have good contrast against dark-colored substrates. Alternatively, a single metallic ink layer could be used with light and dark-colored substrates. When metallic ink is used it can be scanned using MICR or other similar technology.

The mesh carrier 12 is preferably made of polyester, but any porous mesh material such as nylon can be used. Preferably, the mesh has about 180 to 560 threads per inch.

In an alternative embodiment, the mesh carrier 12 could be printed by first printing indicia with a light-colored ink 104 and then reprint the indicia with a dark-colored ink 102. This embodiment is especially well suited to an ink jet printer. However, the dual layer ink ribbon 110 is especially well suited for a thermal transfer printer.

Alternatively, the porous mesh carrier 12 could be pre-printed with indicia using other printing technologies such as screen printing and/or hot stamping to create the mark. This is useful when the information to be printed is static.